

REMARKS/ARGUMENTS

Claims 19-25 were examined in the Office Action under reply, with claims 1-18 having been previously canceled. Claims 19-25 now stand rejected under 35 U.S.C. § 103 over Tuller et al. (U.S. Patent No. 4,042,550) and Lim (U.S. Patent No. 5,925,934) in view of Langari (U.S. Patent No. 6,261,871). The present rejection is addressed in part by the present amendment and is otherwise traversed for reasons that will be discussed in detail below. With the present amendment, only claim 19 has been amended.

We appreciate the withdrawal of the rejection under 35 U.S.C. § 103 over Inomata (JP 2001-139669).

Amendment

Claim 19 has been amended to clarify that the molecular weight of the curing agent is greater than about 1000 g/mole. Support for this amendment can be found, for example, in the specification at ¶¶ [008], [011], [022]-[030]. No new matter has been added.

Claim Rejection Under 35 U.S.C. §103(a)

Claims 19-25 have been examined in the outstanding office action and currently stand rejected under 35 U.S.C. §103(a) as being unpatentable over Tuller et al. (U.S. Patent No. 4,042,550) and Lim (U.S. Patent No. 5,925,934) in view of Langari (U.S. Patent No. 6,261,871). According to the Examiner, Tuller discloses a cured encapsulant resin composition that can be used as an underfill composition, as taught by Lim, and Langari discloses a method of fabricating a semiconductor device by the claimed steps and using an underfill composition therein.

Claim 19 has been amended to recite that the curing agent has a molecular weight above about 1000 g/mol, thereby distinguishing the present invention from Tuller. Moreover, it is respectfully submitted that Tuller does not teach a curing agent as presently claimed. As stated in the present specification, previously known anhydrides that are used in underfill material are

small molecules that have a tendency to volatilize during the curing process, which leads to porosity during the curing process and ultimately leads to system failure. See ¶ [008] of the present specification. The Examiner relies on the abstract and col. 2, lines 32-41 of Tuller, which describes the use of a hardener chosen from polyanhydrides of maleic acid monomers and alkyl styrene monomers, and prepolymers of such polyanhydrides having molecular weights below about 1000. Applicants' curing agents, however, comprise low molecular weight polymers and oligomers, wherein the molecular weight is greater than about 1000 g/mole. For instance, Examples 1-6 pertain to maleic anhydride copolymers of a molecular weight of about 1600 g/mole.

As mentioned above, if the molecular weight of the curing agent is too low, i.e. below 1000 g/mole, then the curing agent will volatilize during processing and cause porosity during curing, which will lead to overall system failure. If the molecular weight of the curing agent is too high, e.g. above 50,000 g/mole, then the curing agent will gel, which causes miscibility and flow problems during processing. By using low molecular weight maleic anhydride polymers and oligomers, applicants have unexpectedly found that volatilization can be controlled (e.g., decreased), especially at high temperatures in, for instance, no flow underfill formulations or in any sudden exposure to high temperatures in a short time, thereby reducing flow problems such as voids and die fails.

The claimed invention is also distinguishable over Tuller with respect to the function of the present curing agents. As explained in ¶ [008] of the present specification, the known anhydrides "typically only perform one function, i.e. cross-linking." Greater cross-linking will result in a harder cured product. Tuller's polyanhydrides having a molecular weight below about 1000 only function as a hardener. While the Examiner states that "applying a styrene/maleic

anhydride copolymer resin composition [of Tuller] as an encapsulant/underfill produces a composition with excellent moisture resistance and wet electrical properties, resulting in a high quality product,” we respectfully assert that the Examiner mischaracterizes the function of the polyanhydrides of Tuller. According to the specification of Tuller, “It has been surprisingly found that the presence of the additional filler, silane coupling agent and lubricant improves the moisture resistance of the electrical properties,” not the use of polyanhydride hardeners. Col. 2, lines 6-10 of Tuller (emphasis added). In fact, the hardeners used in Tuller were not the alleged invention of Tuller at all, as admitted at col. 2, lines 14-16 of Tuller, but were disclosed in the prior art.

Thus, like other known anhydrides, the polyanhydrides of Tuller were only used as hardeners. Tuller is unlike embodiments of the present invention in which the low molecular weight maleic anhydride polymers and oligomers are not only used to improve cross-linking, but can also be designed to modify viscosity, decrease moisture absorption, volatilization and modulus, improve mechanical properties, and/or enhance adhesion. *See* ¶ [009] of the present specification. None of these other functions of the curing agent were disclosed or suggested in Tuller with respect to its polyanhydrides. The different structural designs dictate different requirements for the curing agents themselves as well as the resin compositions containing the curing agents.

Overall, Tuller and Lim do not teach a curing agent that can be used in an underfill composition of amended claim 19 and, as admitted by the Examiner, do not teach a method of fabricating a device as claimed. The combination of Tuller and Lim with Langari does not cure these defects. While Langari discloses a method of fabricating a semiconductor device, the Examiner did not cite Langari as disclosing the claimed curing agents and it is agreed that

Langari does not disclose such. Further, the pending claims 20-25 are allowable as depending from allowable claim 19.

For all the above reasons, applicants respectfully submit that the pending claims define an invention that is novel and nonobvious over the art. A prompt indication of allowable subject matter would be much appreciated.


The Examiner is invited to contact the undersigned at (408) 975-7500 to discuss any matter concerning this application.

The Office is hereby authorized to charge any additional fees or credit any overpayments under 37 C.F.R. §1.16 or §1.17 to Deposit Account No. **11-0600**.

Respectfully submitted,

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